Benefits of feeding Selsaf® selenium yeast to the breeding herd

Adapted from Selenium Management Technical Guide (Phileo by Lesaffre, 2016 and
Optimizing Sow and Piglet Management Technical Guide (Phileo by Lesaffre, 2016)

Dr. Joe Loughmiller, Sr. Swine Technical Services, North America

Why use live yeast probiotics and yeast extracts in nursery feed?

Selenium was first discovered in 1817 by the Swedish chemist, Berzelius. Its ability to produce a shine when cooled rapidly and its similarities to tellurium (coming from the Latin word tellus, meaning earth), caused selenium to be named after the moon (Selene in Greek) (Berzelius, 1817; Duntas and Benvenga, 2015). Although identification of Se was followed by studies of its chemistry, its biological function remained unknown until the discovery of its toxicity in 1934 (Franke, 1934) and, fortunately, its essential nutritional aspects in 1957, 140 years after its discovery (Schwarz and Foltz, 1957). Since then, research has focused on unravelling the metabolic function of Se and its benefits for human and animal health.

Selenium is currently fed to farm animals to reduce Se deficiency, and oxidative stress effects on animal health and meat quality. The inorganic forms are mainly mineral salts, such as sodium selenite (Na-Se) or selenate, while organic forms include synthetic selenomethionine (SeMet) or selenized yeasts like Selsaf, rich in natural Se components.

How is Selsaf brand selenium yeast made?

Selenized yeasts can be produced in various ways, but the highly consistent selenized yeast, Selsaf®, is obtained from the specific cultivation of a proprietary *Saccharomyces cerevisiae* strain on a medium enriched with Na-Se (Figure 1). Selenate is transformed to hydrogen selenide (H2Se) during yeast growth. Hydrogen selenide is an intermediate metabolite used by the yeast to synthesize various organic selenomolecules, such as selenomethionine (SeMet) and selenocysteine (SeCys), but also many other active seleno-compound (Kieliszek et al., 2015)(Fig. 9). Its standardized production procedure means that Selsaf contains 2 natural organic Se fractions which are easily absorbed in the animal's intestine; I) 36% SeCys and other active seleno-compounds and II) 63% SeMet, only differing from the amino acids cysteine and methionine by the replacement of the sulfur atom by a selenium atom. Unlike its inorganic form, whose digestibility is less than 5%, selenium yeast is typically 80-100% absorbed, together with the amino acid in which it is contained. The structure and function of the selenoproteins were reviewed by Huang et al. (2012) and more recently by Labunskyy et al. (2014).

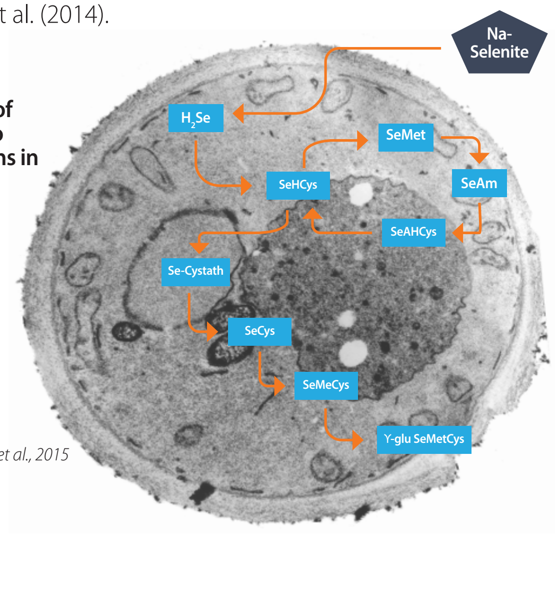


Figure 1: Assimilation of Selenium into Selenoproteins in Yeast Cells.

Kieliszek M. et al., 2015

Selenoproteins and the antioxidant defense

Selenomethionine

Once absorbed, SeMet is not recognized as a source of Se so SeMet is metabolized according to the methionine requirement and is non-specifically incorporated into body proteins. Supplementing animals with Selsaf results in higher Se levels in muscle tissue and lean meat than with the inorganic Se source and other Se-enriched yeast (IRTA, 2007; Mahan and Parrett, 1996; Figures 2 & 3). The non-specific incorporation of SeMet into body proteins and lean muscle mass provides an accessible pool of SeMet during times of stress to improve the antioxidant defense. As the SeMet is released from tissue storage, it is converted into SeCys and utilized as described below. Incorporation of SeMet into eggs, milk and meat also provides added value foods which can be used as a source of organic Se for both humans and animal offspring, improving their Se status and the antioxidant defense.

Selenocysteine

The importance of Se to health is now known to lie in the construction of the 21st amino acid, selenocysteine. Selenocysteine, as the name suggests, only differs from cysteine (Cys) by the replacement of the sulfur atom with the selenium atom but, unlike all other amino acids, it is naturally constructed co-translationally during intracellular protein synthesis (Labunskyy et al., 2014). To date, various proteins containing SeCys in their peptide backbone have been identified and gathered under the name 'selenoprotein' (Figure 1). The SeCys residue in these proteins is mostly likely present in the enzyme's active site for the execution of catalytic redox reactions (Labunskyy et al., 2014; Huang et al., 2012) and therefore not only regulates cell signaling but also helps maintain oxidant balance (Hawkes and Alkan, 2010). Poor selenium acquisition from feed compromises the function of these selenoproteins. It then eventually yields various oxidative stress associated diseases and disorders. One of the most important diseases caused by Se deficiency and present in all animal species is nutritional muscular dystrophy (NMD) or white muscle disease (WMD). This disease is characterized

Figure 2: Effect of Selsaf® Se-Yeast on piglet musle Se levels (IRTA, 2007).

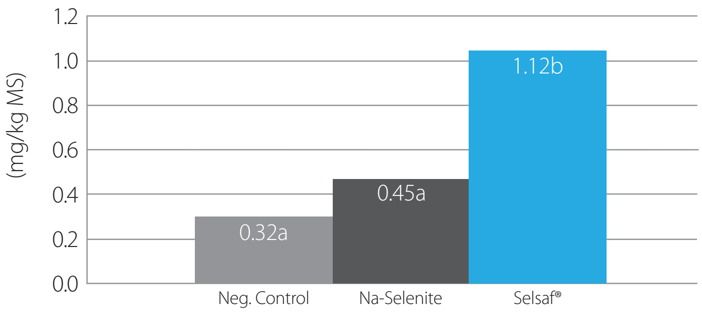
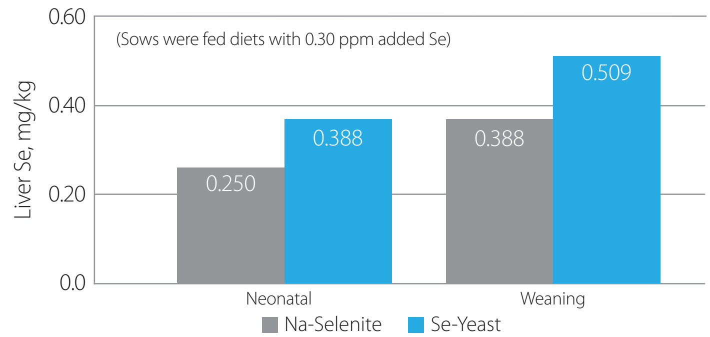


Figure 3: Effects of Se source fed to sows on offspring liver Se levels (Mahan and Parrett, 1996).



by skeletal muscle degeneration which, in the acute form, may lead to tachycardia, arrhythmia, dyspnea at rest, cyanosis and even sudden death, while the chronic form is mainly characterized by difficulties with standing up and maintaining the standing position. Hepatosis dietetica (liver necrosis), mulberry heart disease and reduced spermatogenesis are common symptoms of Se deficiency. Reduced fertility, retained placenta, mastitis and metritis have been also been associated with Se deficiency, most especially in dairy cattle (Gupta et al., 2000; Oldfield, 2002; Zarczynska et al., 2013). Consequently, increasing levels of these selenoproteins by supplementing animal diets with Se can improve not only the antioxidant status of the animal but also the animal-derived end-product, by inhibiting lipid and protein oxidation.

Selenium and the immune system

The latest Se research efforts are focused on its immunological function. These seem linked to selenoenzymes defending against oxidative stress. The binding of a ligand to its receptor can lead to the formation of reactive oxygen species, triggering an oxidative burst. This oxidative burst can be used for signaling by non-phagocytic cells, or for the destruction of microbes by macrophages and neutrophils. Neutrophils from Se-deficient animals are still able to engulf pathogens but are less capable of killing them compared to neutrophils from animals getting adequate Se (Spallholz, 1980). Selenium deficiency can also reduce iodothyronine deiodinase selenoprotein function, causing impaired thyroid function, affecting the neutrophil response. Reduced neutrophil chemotaxis with Se deficiency has been observed, probably due to the reduced synthesis of leukotriene B4 (Arthur et al., 2003).

Adaptive immunity is also affected by Se status, in a similar way to innate immunity. Se depletion and deficiency not only reduces lymphocyte proliferation, but also their differentiation. The higher oxidative status in the cell can favor Th2 cell differentiation. A more balanced oxidative status with adequate Se intake promotes greater differentiation flexibility toward external cues and antigen-presenting cells. Finally, B-cell counts in the liver and in antibody titers also seem to depend on dietary Se levels (Arthur et al., 2013; Huang et al., 2012; Kieliszek and Blazejak, 2016; Steinbrenner et al., 2015).

While further research is required to elucidate the role of many selenoproteins in the immune system, circulating Se levels significantly affect both innate and adaptive immunity.

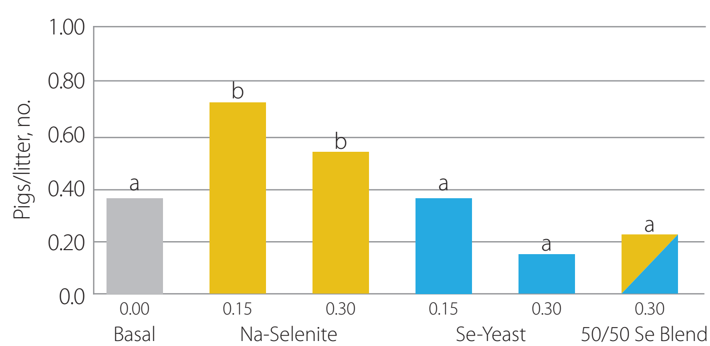
Beneficial effects of organic selenium on oocyte fertilization

Birth weight and homogeneity of the following litter are determined by the quality of the maternal environment as early as pre-implantation. High levels of micronutrients are needed in particular to promote fertilization, well-developed embryos and appropriate implantation. Ovulation and embryonic development are facilitated by the availability of these micronutrients, including selenium. An in vitro study has shown a beneficial effect of selenomethionine on the rate of maturation (Metaphase II) of porcine oocytes and their subsequent fertilization (Tareq et al., 2012).

Beneficial effects of yeast rich in selenium on litter size

Nutrition management of sows (especially gilts) is a key to both sow longevity and reproductive performance. During pregnancy there is a strong demand on, among other things, amino-acids: methionine and cysteine are required for the maintenance of optimal anti-oxidative status, leading to optimal ovulation conditions. In this way, Mahan et al. demonstrated that maternal seleno-methionine intake improves both the selenium and antioxidant status of sows (Fortier et al., 2012). Mahan (1994) also demonstrated that litter size is affected by Se level and source. Sows fed either 0.15 or 0.3 ppm Se from Se Yeast had reduced stillborn piglets than sows fed no added Se or Na-Selenite (Figure 4).

Figure 4: Effect of selenium source fed to sows on litter stillbirths (Mahan 1994).



Conclusion

Selsaf® Selenium yeast is a valuable source of selenium that provides a "dual-action" benefit. It provides both selenomethionine for maximum tissue Se storage and immediately available bioactive selenoproteins from selenocysteine. This is critical to optimize sow and litter productivity, whilst providing storage Se to be used during times of immune challenge, low feed intake, and stress. This dual action also boosts the antioxidant status and the natural immune defenses, improving overall health. Improving animal health directly benefits the pork producer by reducing production costs while improving productivity.